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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61B 6/04, A61G 13/06 — A1

(11) International Publication Number: **WO 98/46137**

(43) International Publication Date: 22 October 1998 (22.10.98)

(21) International Application Number: PCT/NL98/00171

(22) International Filing Date: 27 March 1998 (27.03.98)

(30) Priority Data:
1005797 11 April 1997 (11.04.97) NL

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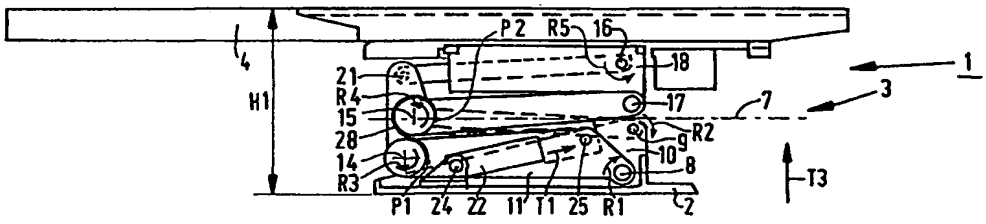
(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
In English translation (filed in Dutch).

(54) Title: A DEVICE SUITABLE FOR TRANSLATING AN OBJECT IN THE DIRECTION OF TRANSLATION, AND ALSO A PATIENT TABLE



(57) Abstract

A device which is suitable for translating an object in a direction of translation, which device comprises two parallelogram constructions which are similar in shape, which are disposed in mirror symmetry with respect to a plane of symmetry extending transversely to the direction of translation. Each parallelogram construction comprises four legs, which form two pairs of legs having the same length, whereby each first length leg is pivotally connected with each end, by means of a pivot pin, to a second length leg. A pivot pin of the first parallelogram construction coincides with the pivot pin of the second parallelogram construction, whereby the coinciding pivot pins lie in the plane of symmetry. A first length leg of the first parallelogram construction is rigidly connected to a first length leg of the second parallelogram construction. Furthermore, means are provided for pivoting the second length legs of the first parallelogram construction through a pivoting angle, and at the same time pivoting the second length legs of the second parallelogram construction through a pivoting angle of the same magnitude in opposite direction.

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A device suitable for translating an object in the direction of translation, and also a patient table.

The invention relates to a device which is suitable for translating an object in a direction of translation.

The invention also relates to a patient table provided with such a device.

A device of this type is used for vertical adjustment of a patient table, among other things. A known device is for example a piston, which is movable within a cylinder under pneumatic or hydraulic pressure.

When vertically adjusting a patient table, for example for X-ray examination of X-ray treatment, the position of the patient table in horizontal direction must be precisely maintained. When a piston which is movable within a cylinder is used, the piston-cylinder combination must be of comparatively heavy construction to that end. Alternatively, additional rectilinear guide means may be used. This makes the patient table relatively complicated, however. Another drawback of the use of a piston which is movable within a cylinder, is the fact that the maximum height that can be reached cannot be more than twice the minimum height, so that the vertical adjusting range is relatively limited.

The object of the invention is to provide a device by means of which an object can be moved over a relatively long distance in a direction of translation in a relatively simple manner.

This object is achieved with the device according to the invention in that the device comprises two parallelogram constructions, which are disposed in mirror symmetry with respect to a plane of symmetry extending transversely to the direction of translation, whereby each parallelogram construction comprises four legs, which form two pairs of legs having the same length, whereby each first length leg is pivotally connected with each end, by means of a pivot pin, to a second length leg, whereby a pivot pin of the first parallelogram construction coincides with the pivot pin of the second parallelogram construction, whereby the coinciding pivot pins lie in the plane of symmetry, whereby a first length leg of the first parallelogram construction is rigidly connected to a first length leg of the second parallelogram construction, whilst means are provided for pivoting the second length legs of the first parallelogram

construction through a pivoting angle, and at the same time pivoting the second length legs of the second parallelogram construction through a pivoting angle of the same magnitude in opposite direction.

By pivoting the second length legs of the two parallelogram constructions through opposed angles, the first legs of the parallelogram constructions facing away from the plane of symmetry are moved towards and away from each other in the direction of translation. Since the angles through which the legs having the same length are pivoted are identical, a defined translation of the legs having the same length with respect to each other takes place in a direction transversely to the direction of translation.

Since the first length legs located near the plane of symmetry are rigidly interconnected, mutual pivoting with the first length legs remote from the plane of symmetry is not possible.

Since the legs are pivotally interconnected, the difference between the minimum and the maximum dimension of the device in the direction of translation may be relatively large.

One embodiment of the device according to the invention is characterized in that the second length legs of the two parallelogram constructions have the same length.

Since the angles through which the second length legs are pivoted are identical, and since all the second length legs have the same length, no mutual translation of the first length legs in a direction transversely to the direction of translation will take place. This makes the device suitable for carrying out a precise movement in the direction of translation, whereby movements in directions extending transversely to the direction of translation are prevented.

Another embodiment of the device according to the invention is characterized in that a second length leg of the first parallelogram construction is coupled to a second length leg of the second parallelogram construction near the rigidly interconnected first length legs of the first and the second parallelogram construction, with the aid of means for pivoting the second legs of the second parallelogram construction through an identical pivoting angle in opposite direction.

In this manner it is ensured that the second length legs of the parallelogram constructions are always pivoted through an identical angle in opposite direction. Said means may for example be

meshing gears, which are rotatable about said pivot pins.

Another embodiment of the device according to the invention is characterized in that the interconnected second length legs are provided with bushes, which are rotatable about said pivot pins, and which are coupled by means of a flexible belt, which belt is attached to one leg, which is partially passed over the bush connected to said leg in anti-clockwise direction, which extends between said bushes towards the other bush, which is partially passed over the other bush in clockwise direction, and which is attached to the leg provided with the other bush.

When the second length legs pivot with respect to each other, the belt will be unwound from one bush and be wound onto the other bush. As a result of this a uniform transmission of the angular rotation from one leg to the other leg is obtained.

Another embodiment of the device according to the invention is characterized in that said flexible belt comprises a plurality of cords arranged in side-by-side relationship.

If one of the cords breaks, the force being exerted thereon will be taken over by the other cords, as a result of which a uniform translation of the object remains ensured.

The invention will be explained in more detail hereafter with reference to the drawings, in which:

Figure 1 shows a patient table according to the invention in folded condition;

Figure 2 shows the patient table shown in Figure 1 according to the invention in extended condition;

Figure 3 is a perspective view of a patient table according to the invention;

Figure 4 is an enlarged perspective view of a part of the patient table shown in Figure 3; and

Figure 5 is a longitudinal section of the patient table shown in Figure 3.

Parts that correspond with each other are indicated by the same numerals in the figures.

Figures 1 and 2 show a patient table 1 according to the invention, in folded condition and in extended condition respectively. Patient table 1 is provided with a support 2, a moving device 3 connected to said support 2, and a top 4 connected to moving device 3, on which a

patient can be supported. The invention will be explained by means of a patient table, but it will be understood that the moving device 3 according to the invention may be used for moving any given object with respect to another object.

Moving device 3 comprises two parallelogram constructions 5, 6, which are disposed in mirror symmetry with respect to a plane of symmetry 7 extending between support 2 and top 4. First parallelogram construction 5 is provided with two rigidly disposed pivot pins 8, 9, between which a first leg 10 having a first length L1 extends. Parallelogram construction 5 is furthermore provided with two parallel legs 11, 12, which pivot about pivot pins 8 and 9 respectively. Legs 11, 12 are pivotally connected, on a side remote from pivot pins 8, 9, to a knee member 13, whereby leg 11 pivots about a pivot pin 14 with respect to knee member 13, whilst leg 12 pivots about a pivot pin 15 with respect to knee member 13. Leg members 11, 12 have an effective length L2 which equals the distance between pivot pins 8 and 14 or between pivot pins 9 and 15. The distance between pivot pins 14, 15 equals the length L1 of first leg 10, whereby the part of knee member 13 that extends between pivot pins 14, 15 forms one leg of parallelogram construction 5, whose length L1 corresponds with the length of leg 10.

Second parallelogram construction 6 is arranged in mirror symmetry with parallelogram construction 5 with respect to plane of symmetry 7. Plane of symmetry 7 extends through pivot pin 15. Parallelogram construction 6 is provided with two pivot pins 16, 17, which are rigidly connected to top 4, between which a first leg 18 having a length L1 extends. Parallelogram construction 6 is furthermore provided with two parallel legs 19, 20 having an effective length L2, which are pivotally connected, on a side remote from pivot pins 16, 17, to knee member 13 via pivot pins 21 and 15 respectively. The distance between pivot pins 15, 21 is the same as the distance between pivot pins 16, 17, whereby the part of knee member 13 that extends between pivot pins 15 and 21 forms a leg of parallelogram construction 6 that extends parallel to leg 18.

Parallelogram constructions 5, 6 are arranged in mirror symmetry with respect to plane of symmetry 7, in the sense that the pivot pins of parallelogram constructions 5, 6 are arranged in mirror symmetry with respect to plane of symmetry 7. The legs do not necessarily have to be each other's mirror image as regards their specific shape.

Patient table 1 is furthermore provided with a piston 23, which is capable of movement within a cylinder 22, whereby the cylinder is pivotally connected to support 2, on a side remote from piston 23, by means of pivot pin 24, whilst the piston is pivotally connected to leg 11 of first parallelogram construction 5, on a side remote from cylinder 22, by means of a pivot pin 25.

Knee member 13 rigidly interconnects leg members having a first length L1 of first parallelogram construction 5 and second parallelogram construction 6. Leg 11 is provided with a bush 26, whose central axis coincides with axis of rotation 14. Leg 20 is provided with a bush 27, whose central axis coincides with axis of rotation 15. A flexible, non-extendible belt 28 is passed over bushes 26, 27, which belt is connected to leg 11 with one end, and to leg 20 with the other end. With the patient table 1 that is diagrammatically shown in Figures 1 and 2, belt 28 is connected to bush 26 at a point P1 which is located on a connecting line between pivot pins 8 and 14. Belt 28 is connected to bush 27 at a point P2 which is located on a connecting line between pivot pins 17 and 15. As can be seen in Figure 1, belt 28 extends through approximately 270° in anti-clockwise direction over bush 27, whilst belt 28 extends through approximately 90° in clockwise direction over bush 26. The positions of connecting points P1, P2 have been selected such that the operation of the patient table can be readily derived from Figures 1 and 2. Connecting points P1, P2 may also be positioned elsewhere, however.

The operation of patient table 1 is as follows. From the folded position of the patient table 1 that is shown in Figure 1, piston 23 is telescoped from cylinder 22 in a direction indicated by arrow T1, for example by pneumatic or hydraulic means. As a result of this, pivot pin 25 and the leg 11 connected thereto are pivoted in a direction indicated by arrow R1. As a result of the pivoting movement of leg 11 in the direction indicated by arrow R1, also the leg 12 that extends parallel to leg 11 is pivoted about pivot pin 9 in the direction indicated by arrow R2, whereby pivoting movement R2 is identical to pivoting movement R1 as a result of the parallelogram construction 5. As a result of the simultaneous pivoting of the two legs 11, 12, the knee member 13 is moved upwards in a direction indicated by arrow T3, and at the same time it is moved in a direction indicated by arrow T4, transversely to the direction

of translation T3. The bush 26 that is connected to leg 11 is thereby pivoted with respect to knee member 13 in a direction indicated by arrow R3, whereby belt 13 is wound onto bush 26. As a result of this, belt 28 is unwound from bush 27, under rotation of bush 27 in a direction indicated by arrow R4, opposed to the direction indicated by arrow R3. As a result of the rotation of bush 27 in the direction indicated by arrow R4, also the leg 20 connected to bush 27 is pivoted in the direction indicated by arrow R4. As a result of the parallelogram construction 6, leg 19 is simultaneously pivoted about pivot pin 21 in a direction indicated by arrow R5. As a result of the simultaneous pivoting movement of legs 19, 20, the part 18 that is rigidly connected to top 4 is moved upwards in a direction indicated by arrow T3 with respect to knee member 13, whilst it is simultaneously moved to the left, in a direction opposed to the direction indicated by arrow T4, with respect to knee member 13. Since the first and the second lengths of the legs of parallelogram constructions 5, 6 are the same, the movement of knee member 13 in the direction indicated by arrow T4 is of exactly the same magnitude as the movement of top 4 in a direction opposed to the direction indicated by arrow T4 with respect to knee member 13. As a result of this, top 4 will not move at all in a direction indicated by arrow T4, or in a direction opposed thereto, with respect to support 2.

In the position of the patient table 1 that is shown in Figure 2, an upper side 30 of top 4 is positioned at a distance H2 from a bottom side 31 of support 2. In the folded position of patient table 1 that is shown in Figure 1, this distance is H1. The distance H2 amounts to nearly three times the distance H1. The difference between these two distances may be further increased by increasing the length L2 of legs 11, 12, 19, 20.

Figures 1 and 2 are merely diagrammatic representations of the patient table 1 according to the invention. Figures 3 - 5 show a detailed embodiment of the patient table according to the invention. Figure 3 is a perspective view of a patient table 40 according to the invention, which comprises a support 2, a moving device 41 connected to support 2, and a top 4 connected to moving device 41. The moving device 41 comprises parallelogram constructions 42, 43. Parallelogram construction 42 comprises two parallel parallelogram constructions 5, whereby legs 11 are kept spaced apart by a bush 26 extending between legs 11, and legs 12 are positioned

on the sides of knee members 13 that face away from each other, which knee members are kept spaced apart by bush 27. Legs 11, 12 are pivotally connected to flanges 44 near support 2. Parallelogram construction 43 comprises two parallel parallelogram constructions 6, wherein legs 20 are interconnected by bush 27. Legs 19 engage knee members 13 on sides facing away from each other, whereby a pin 45 extends between knee members 13. A cross-shaped stiffening element 46 is disposed between legs 20, thus providing a relatively great stiffness of the interconnected legs 20.

Figure 4 shows a longitudinal section of the device 40 that is shown in Figure 3, in which the belt 28 that is passed over bushes 26, 27 is clearly discernible. Belt 28 comprises a plurality of steel wires 46 extending parallel to each other, which are connected with one end 47 to a bracket 48 extending between legs 20. Steel wires 46 are connected with ends 49 remote from ends 47 to a plate 50, which extends between legs 11. Plate 50 is provided with tensioning mechanisms (not shown), by means of which steel wires 46 can be tensioned. The tautly tensioned steel wires 46 provide a relatively great stiffness of patient table 40 in a direction transversely to arrows T3, T4. The patient table is furthermore provided with two cords 51 abutting against legs 11, 20, which are connected to leg 11 with one end 52 and to leg 20 with another end 53. Each cord 51 extends between rollers 26, 28 in a direction opposed to the direction of steel wires 46, whereby steel wires 46 and cords 51 cross each other, as it were. This can be clearly seen in Figure 5.

The operation of the patient table 40 shown in Figures 3 - 5 corresponds with the operation of the patient table 1 that is shown in Figures 1 and 2. The telescoping movement of piston 23 from cylinder 22 causes leg 11 to pivot about pivot pin 8 in the direction indicated by arrow R1, as a result of which knee member 13 is pivoted upwards in a direction indicated by arrow T3, and to the right in a direction indicated by arrow T4. Bush 26 thereby pivots with respect to knee member 13, in a direction indicated by arrow R3, as a result of which a pulling force is exerted on steel wires 46, and the steel wires are pulled against bush 26. Since the steel wires 46 are also connected to the bracket 48, which is connected to legs 20, bush 27 will be pivoted in a direction indicated by arrow R4, which is opposed to the direction indicated by arrow R3, as a result of the steel wires 46 being wound onto bush 26. As a result of the pivoting movement of legs 20 in the direction indicated by arrow

R4, also legs 19 will be moved in the direction indicated by arrow R5, as a result of which the top 4, which is connected to legs 19, 20, will be moved upwards in a direction indicated by arrow T3, and to the left with respect to knee member 13, in a direction opposed to the direction indicated by arrow T4. Since the angle through which the legs are pivoted is identical in the direction indicated by arrows R1, R2, R3, but said pivoting takes place in a direction opposed to the direction of the angle through which legs 19, 20 are pivoted, which direction is indicated by arrows R4, R5, the movement of the knee member 13 in the direction indicated by arrow T4 is identical to the movement of top 4 in a direction opposed to the direction indicated by arrow T4 with respect to knee portion 4, as a result of which top 4 will not move with respect to support 2 in a direction indicated by arrow T4, or in a direction opposed thereto. Top 4 is only moved with respect to support 2 in a direction indicated by arrow T3, or in a direction opposed thereto.

While cables 46 are wound onto bush 26, cords 51 are unwound from bush 26, and they are simultaneously wound onto bush 27. As a result of the presence of cords 51, the stiffness of patient table 40 will also be relatively large if a force is exerted on top 4 in a direction away from support 2. Such a force may for example be exerted if it is attempted to lift patient table 40 by top 4. In addition to that, the cords support the winding and unwinding of the steel wires onto and from bushes 27 and 26 respectively when top 4 is being moved in a direction opposed to the direction indicated by arrow T3.

Instead of using a plurality of steel wires 46, it is also possible to use a single belt. Instead of using a belt 28, it is also possible to provide bushes 26, 27 with meshing gears, whereby the gears have the same dimension. In comparison with a belt, however, gears have the drawback of a non-uniform movement. It is also possible to provide bush 27 at the location of pivot pin 21.

It is also possible to provide top 4 with a drive mechanism, by means of which leg 19 or 20 can be pivoted about pivot pin 16 or 17, whereby a translation of top 4 in a direction indicated by arrow T3 is effected as a result of a simultaneous pivoting movement of legs 11, 12 and legs 19, 20 in opposite directions. Such a driving arrangement has this drawback, however, that when the two drive mechanisms do not operate completely synchronously, top 4 will also be moved in a direction

indicated by arrow T4, or in a direction opposed thereto.

It is also possible to use a screwed spindle instead of a piston which is movable within a cylinder.

Furthermore, the first length legs of the two parallelogram constructions may have different lengths.

If the lengths of the second length legs of the two parallelogram constructions are not the same, a movement transversely to the direction of translation will take place. The extent of this movement depends directly on the lengths and on the angular displacement.

CLAIMS

1. A device which is suitable for translating an object in a direction of translation, characterized in that the device comprises two parallelogram constructions, which are disposed in mirror symmetry with respect to a plane of symmetry extending transversely to the direction of translation, whereby each parallelogram construction comprises four legs, which form two pairs of legs having the same length, whereby each first length leg is pivotally connected with each end, by means of a pivot pin, to a second length leg, whereby a pivot pin of the first parallelogram construction coincides with the pivot pin of the second parallelogram construction, whereby the coinciding pivot pins lie in the plane of symmetry, whereby a first length leg of the first parallelogram construction is rigidly connected to a first length leg of the second parallelogram construction, whilst means are provided for pivoting the second length legs of the first parallelogram construction through a pivoting angle, and at the same time pivoting the second length legs of the second parallelogram construction through a pivoting angle of the same magnitude in opposite direction.

2. A device according to claim 1, characterized in that the second length legs of the two parallelogram constructions have the same length.

3. A device according to claim 1 or 2, characterized in that a second length leg of the first parallelogram construction is coupled to a second length leg of the second parallelogram construction near the rigidly interconnected first length legs of the first and the second parallelogram construction, with the aid of means for pivoting the second legs of the second parallelogram construction through an identical pivoting angle in opposite direction.

4. A device according to claim 3, characterized in that the interconnected second length legs are provided with bushes, which are rotatable about said pivot pins, and which are coupled by means of a flexible belt, which belt is attached to one leg, which is partially passed over the bush connected to said leg in anti-clockwise direction, which extends between said bushes towards the other bush, which is partially passed over the other bush in clockwise direction, and which is attached to the leg provided with the other bush.

5. A device according to claim 4, characterized in that said flexible belt comprises a plurality of cords arranged in side-by-side relationship.

6. A device according to claim 4 or 5, characterized in that said interconnected legs are furthermore provided with a flexible, elongated element, which is coupled to said legs with its ends, and which abuts against said bushes opposed to said belt.

7. A device according to claim 3, characterized in that the interconnected second length legs are provided with meshing gears, which are rotatable about pivot pins, which gears have identical diameters.

8. A patient table provided with a support, a top which is movable in a direction of translation with respect to said support, and a device according to any one of the preceding claims, which is disposed between said support and said top.

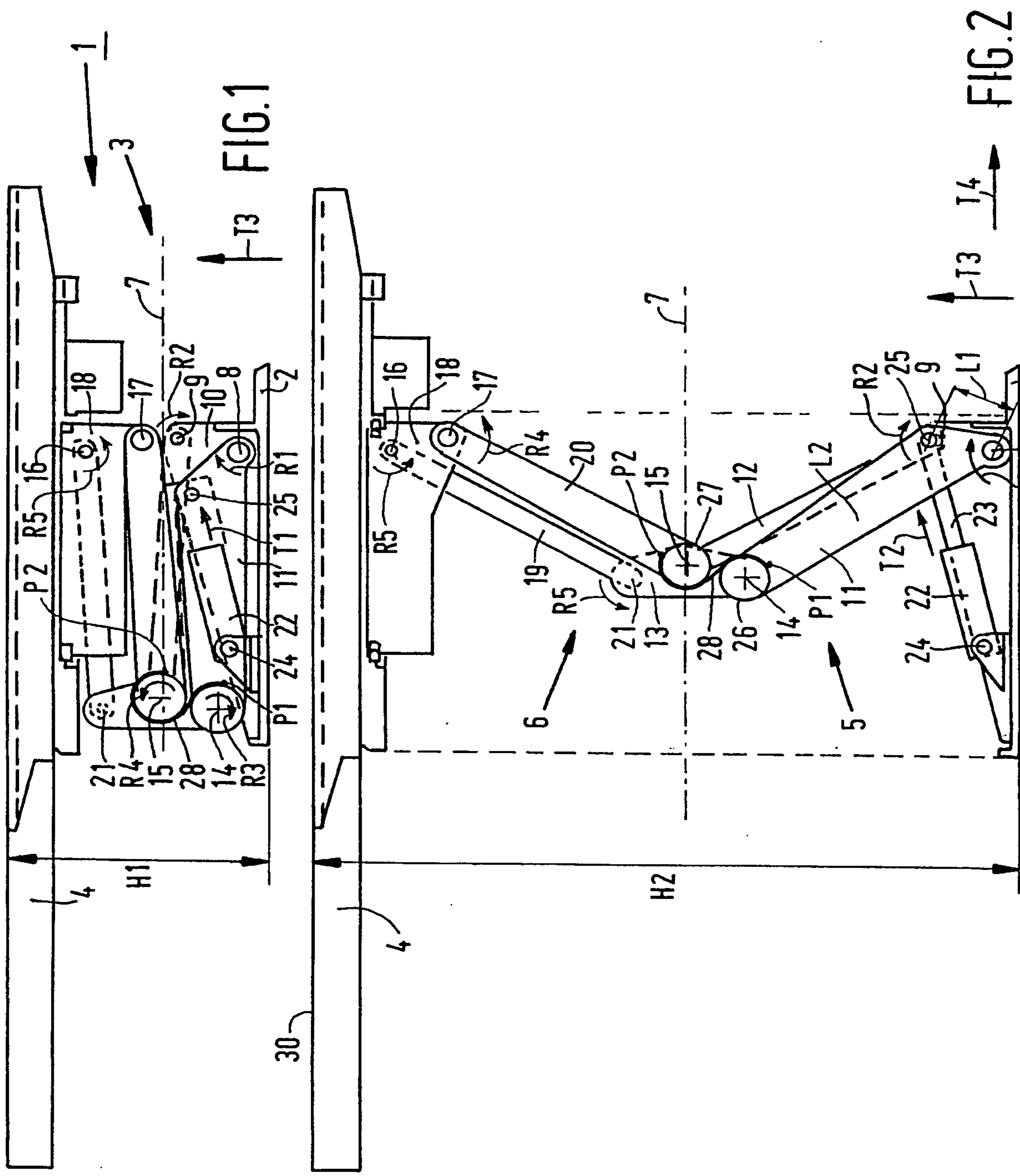
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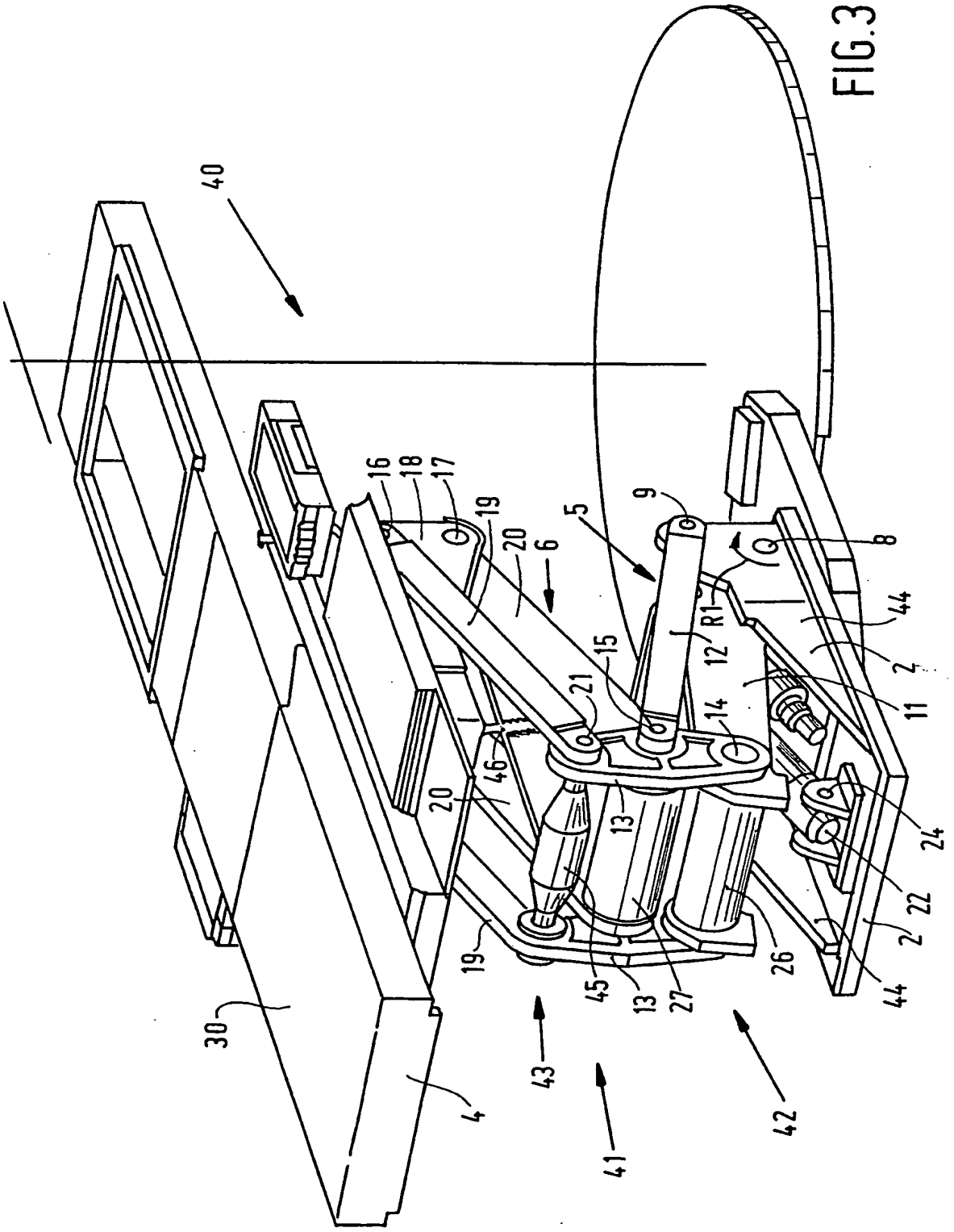
FIG.1

FIG.2

FIG.3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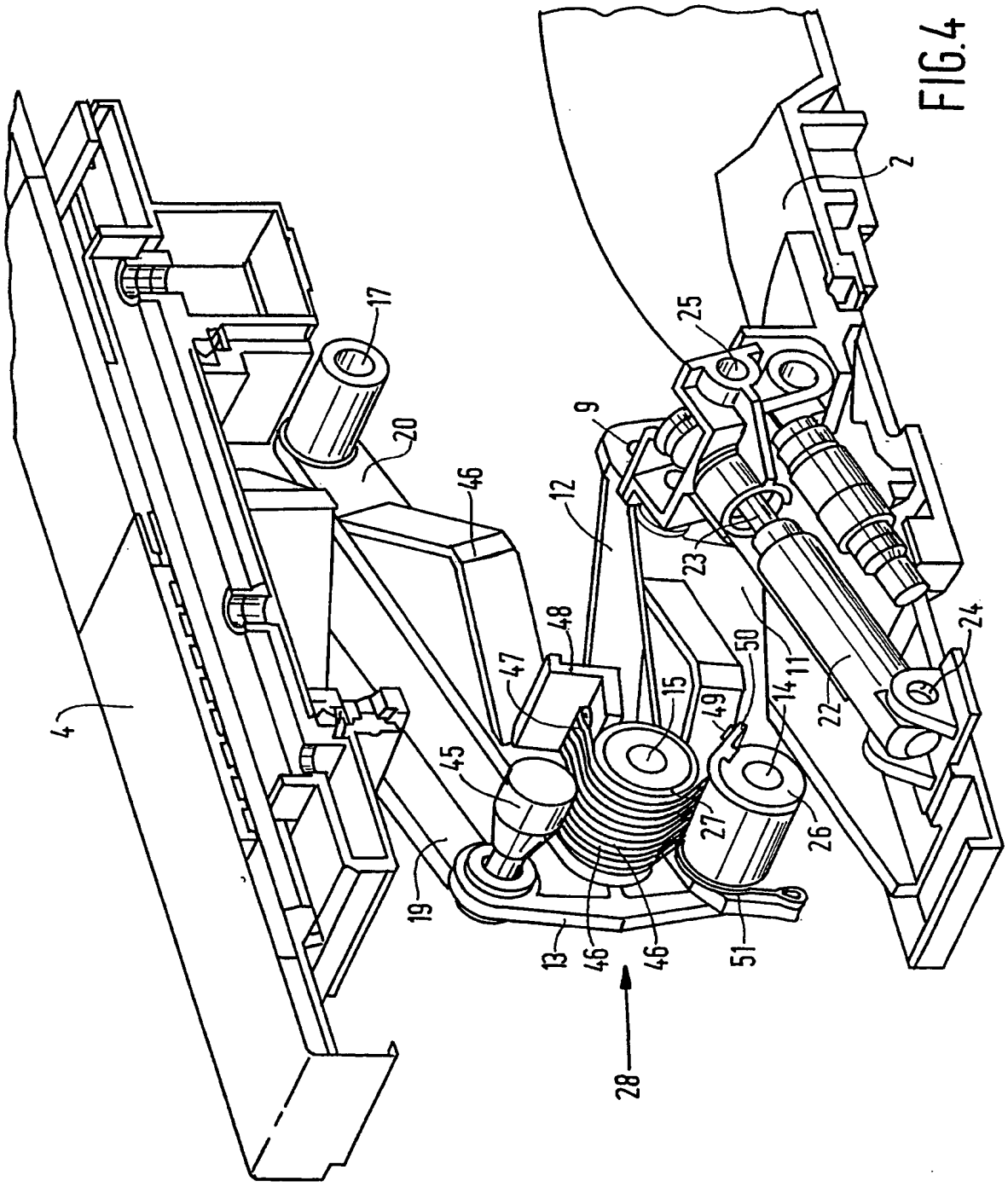
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FIG.4

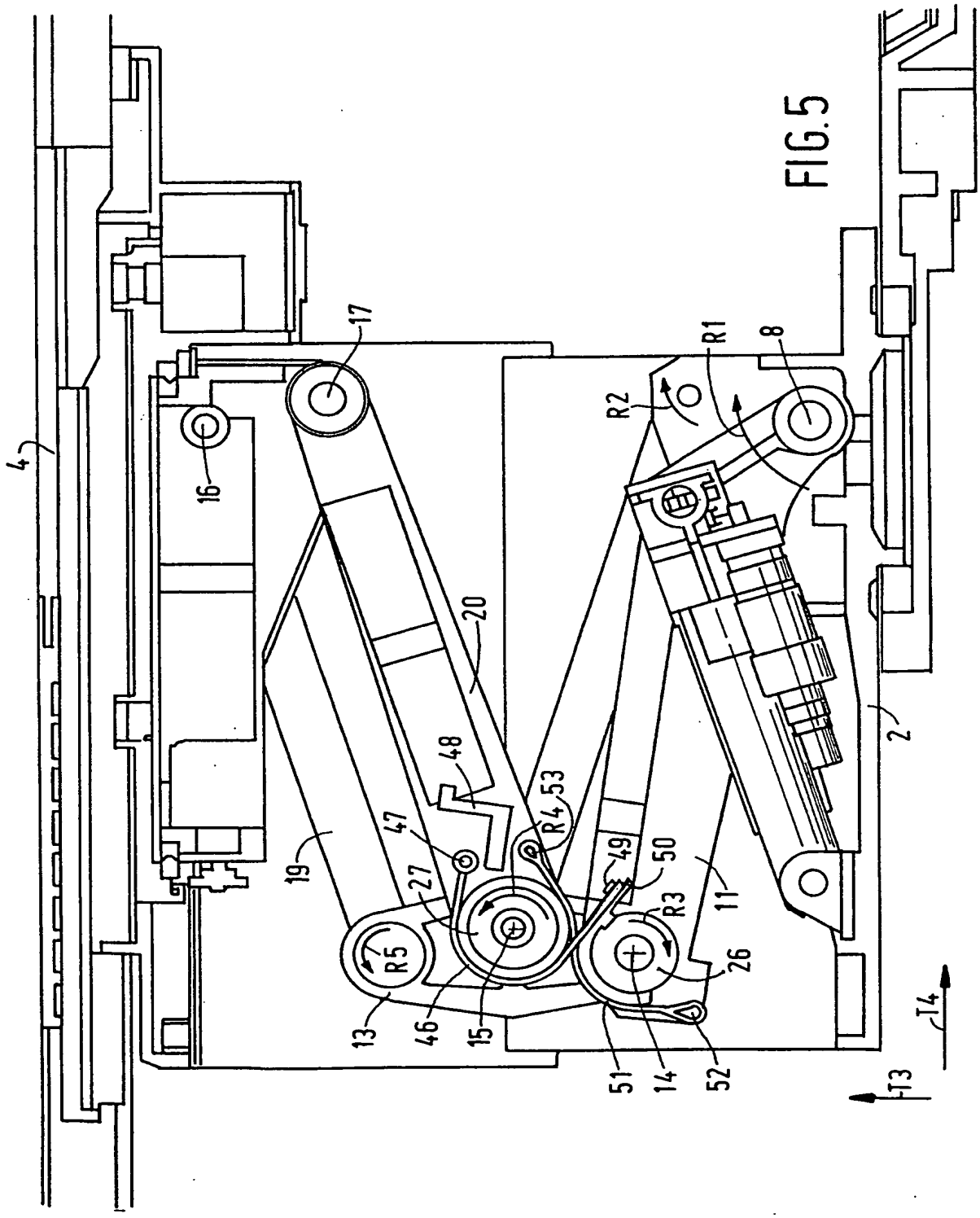
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FIG.5

INTERNATIONAL SEARCH REPORT

Im tional Application No
PCT/NL 98/00171

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A61B6/04 A61G13/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61B A61G B66F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 019 604 A (BENSON LYMAN DAVID) 26 April 1977 see column 3, line 9 - column 6, line 27; figures 1,2	1-3
A	US 5 129 480 A (GARRETT GREGORY E ET AL) 14 July 1992 see column 3, line 27 - column 4, line 14; figures 3-6	1-3
A	DE 22 01 921 B (SIEMENS AG) 12 July 1973 see column 1, line 38 - line 41 see column 2, line 13 - line 21 see column 3, line 33 - column 4, line 58; figures 2,3	1-3,8

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[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
5 June 1998	16/06/1998

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INTERNATIONAL SEARCH REPORT

Int ional Application No
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